# fNIRS-fMRI Reliability for Motor and Social Perception Paradigms: Validation of fNIRS Against fMRI

**J. Adam Noah**[1], X. Zhang[1], D. Purushothaman[3], S. Sanchez-Alonso[4], V. L. Gracco[7], D. J. Ostry[8], N. Rao[5], M. Tiede[6], J. Hirsch[2]

[1]Yale School of Medicine, New Haven, CT; [2]Department of Psychiatry, Yale School of Medicine, New Haven, CT; [3]Department of Psychiatry, Yale University, New Haven, CT; [4]Yale University, New Haven, CT; [5]Yale Child Study Center, New Haven, CT; [6]Yale University, New Haven, CT; [7]Haskins Laboratories, New Haven, CT; [8]McGill University, Montreal, QC, Canada

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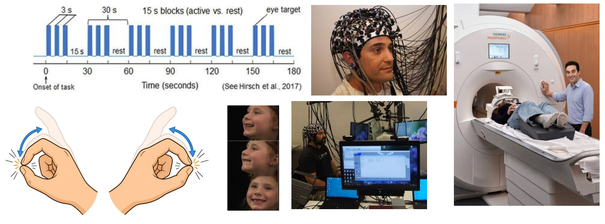
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## Introduction

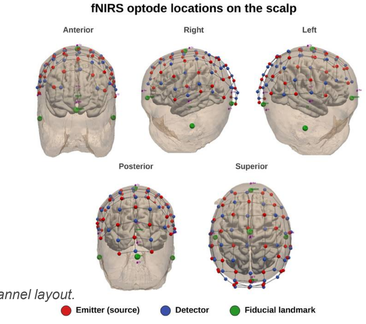
- fNIRS holds significant potential for naturalistic tasks in developmental and social neuroscience.
- Its reliability relative to fMRI requires systematic validation beyond fiducial tasks.
- **Aim:** compare fNIRS hemodynamic responses with fMRI BOLD signal using two calibrated benchmark paradigms – a motor task and a dynamic face (social perception) task.

## Methods

- **Participants:** N = 20 participants [age range, mean ± SD; sex; handedness]
- **fNIRS:** Shimadzu LABNIRS 40x40 fNIRS system
- **fMRI:** Siemens MAGNETOM Prisma 3T (BOLD)
- **Benchmark paradigms:** both served as calibrated stimuli for fNIRS–fMRI comparison.
- **Paradigm 1 – Finger-thumb tapping:** lateralized (left / right hand); targets primary sensorimotor cortex as a spatially focal benchmark.
  - Block design: 15 s tapping / 15 s rest; 6 min total recording; identical for fNIRS and fMRI.
- **Paradigm 2 – Dynamic faces:** stimuli from Pitcher, Dilks, Saxe, Triantafyllou & Kanwisher (2011)[1] – pre-recorded videos of children's faces smiling, moving and chewing; targets the posterior superior temporal sulcus (pSTS).




*Experimental paradigm and task timing.*

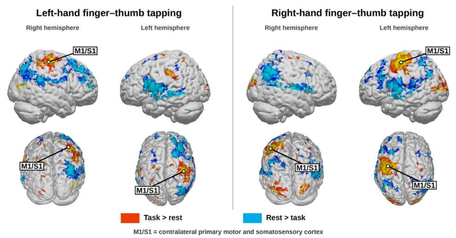



*fNIRS optode / channel layout.*

## Results – Motor Task

### fNIRS reproduces fMRI hemispheric lateralization for left- vs. right-hand tapping

- Robust fNIRS–fMRI correspondence in hemispheric lateralization of primary sensorimotor cortex.



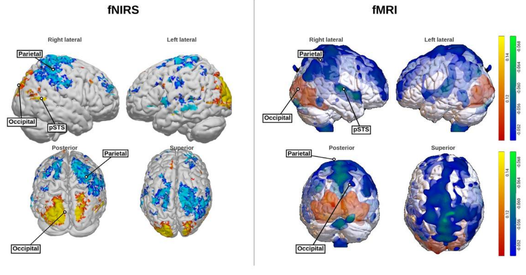

*fNIRS motor activation, left panel shows left-handed finger-thumb tapping and right panel shows right-hand tapping (cortical surface render).*




*fMRI (BOLD) motor activation Right panel – Right-handed finger thumb tapping. Left panel – left-handed finger-thumb tapping.*

## Results – Dynamic Faces

### fNIRS and fMRI also detect the dynamic-face network, including multiple posterior superior temporal sulcus (pSTS) sites

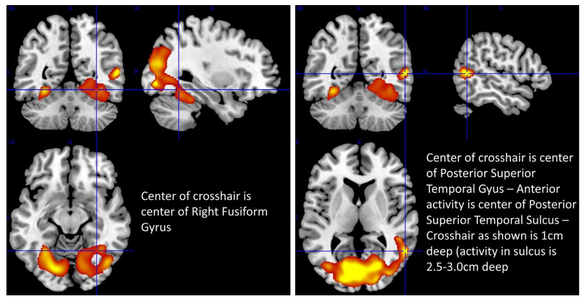



*Left: NIRS activation, dynamic faces (cortical surface render). Right: fMRI rendered data showing positive and negative BOLD response during dynamic face watching task*

## Results – Dynamic Faces (cont)

- fNIRS reliably detected activity in visual cortex, lateral-occipital cortex
- Activity also seen in superior and middle temporal lobes, and pSTS.
- Signal correspondence compared against BOLD with high spatial correspondence.

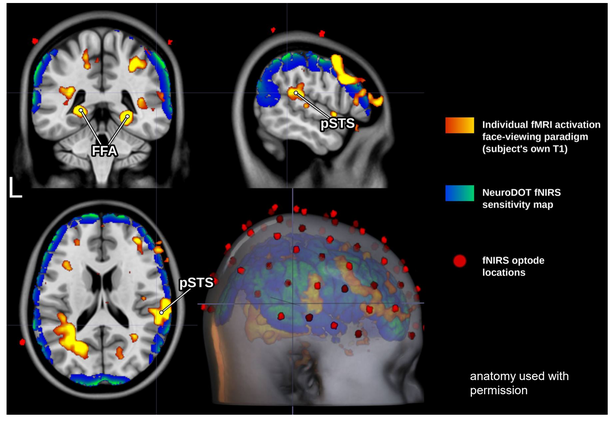
*Additional fMRI renders showing depth of signal. fNIRS has depth into superficial cortex roughly equal to half the distance of the source detector optode separation.*




*fMRI comparison of depth of activity in FFA and pSTS.*

**Visualization note:** fMRI data are truly volumetric (3D) and are shown on a semi-transparent glass brain with sulci visible. Continuous-wave fNIRS is not true 3D data; fNIRS results are shown as cortical surface renders, with depth limited by the NeuroDOT sensitivity model. Direct fNIRS–fMRI comparisons should account for this difference.

## Results – Dynamic Faces (in progress)




*fNIRS sensitivity map determined using NeuroDOT and individual fMRI/T1. Single subject representation of combined fNIRS/fMRI pipeline integrating NeuroDOT sensitivity map to determine fNIRS sensitivity within superficial and deeper regions of the FFA and pSTS[2].*

## Discussion

- fNIRS and fMRI show strong spatial correspondence in motor and face video tasks.
- fMRI constrains social stimuli to camera-recorded video, eliminating two defining features of natural social exchange:
  - **Gaze reciprocity:** eye contact cannot be returned by a recorded face.
  - **Facial mimicry:** a video cannot respond to or mirror the participant's own expressions.
- fNIRS imposes neither limitation: live face-to-face interaction with fully contingent, bidirectional gaze and facial affect.
- This ecological advantage matters most for populations where naturalistic social exchange is central to the research question.
- **Limitation:** continuous-wave fNIRS is not true 3D (depth-limited cortical measures), whereas fMRI is volumetric; cross-modal comparisons must account for this.
- **Future Goals:** We are developing integrated methods into our pipeline to compare the sensitivity of fNIRS to fMRI at the different depths of the pSTS in face processing.

## Conclusions

- **fNIRS and fMRI show spatial reliability across both the motor and social perception paradigms.**
- **These findings validate fNIRS as a platform for developmental contexts where fMRI is impractical and ecological validity is essential.**

## References

1. Pitcher, D., Dilks, D. D., Saxe, R. R., Triantafyllou, C., & Kanwisher, N. (2011). Differential selectivity for dynamic versus static information in face-selective cortical regions. *NeuroImage*, *56*(4), 2356–2363. https://doi.org/10.1016/j.neuroimage.2011.03.067
2. Eggebrecht AT, Culver JP. NeuroDOT: an extensible Matlab toolbox for streamlined optical functional mapping. *Proc. SPIE*, Diffuse Optical Spectroscopy and Imaging VII, 2019. https://doi.org/10.1117/12.2527164

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Contact: [adam@adamnoah.com or adam.noah@yale.edu]

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